

**NWFSC Watershed Program Open House  
NOAA Western Regional Center  
7600 Sand Point Way NE  
Seattle, Washington  
March 12, 2013**

<http://www.nwfsc.noaa.gov/research/divisions/fed/wpg/index.cfm>

- 9:00 – 9:10     Welcome – John Stein, Science and Research Director, Northwest Fisheries Science Center
- 9:10 – 9:20     Overview of Watershed Program research – Phil Roni, Program Manager, Northwest Fisheries Science Center

**Session 1 – Estuarine/Nearshore**

- 9:20 – 9:40     **Evaluating the status of Puget Sound's nearshore pelagic foodweb.**  
C. Greene, C. Rice, L. Rhodes (REUT, NWFSC), J. Hall, J. Chamberlin, J. Cordell (UW), B. Beckman (REUT, NWFSC)

Basic information on Puget Sound's nearshore pelagic zone is lacking on differences among oceanographic basins, linkages between abiotic features, water quality, and pelagic biota, and the effects of anthropogenic activities. To examine these linkages, we conducted a multi-trophic level assessment in six oceanographic basins within Puget Sound using a sampling scheme designed to detect differences among six basins across seasons, and relationships between nearshore pelagic ecosystem attributes and land use in catchments surrounding sites. Measurements included abiotic conditions and nutrient availability, and abundance and diversity of phytoplankton, bacteria, zooplankton, jellyfish, and pelagic fish species. Most of these attributes exhibited strong spatial structure despite seasonal changes. These patterns indicate that different pelagic food webs exist across the system, and that target conditions, current status, or both, cannot be uniform across greater Puget Sound. Furthermore, many of the potential indicators we measured were sensitive to measures land use, with a general pattern that abiotic and lower trophic patterns were most sensitive, and patterns in fish abundance and diversity were the least sensitive. Despite these patterns, land use rarely explained more than 5% of the variation in observed data, indicating a dominant marine influence and the potential for resilience of Puget Sound's pelagic waters to anthropogenic influence.

9:40 – 10:00 **Comprehensive restoration monitoring in the Snohomish River estuary: project and landscape contexts.**

C. Rice, J. Chamberlin, J. Hall, T. Zackey (Tulalip Tribes), H. Zox (Contractor), H. Imaki (Contractor), P. Roni, K. Fresh (FE, NWFSC)

The Snohomish River is the second largest watershed in Puget Sound and home to a rich community of fish and wildlife, including salmonids listed under the federal Endangered Species Act (ESA). Historically the Snohomish had approximately 4,000 hectares of estuarine wetland, 85% of it diked for agricultural and industrial uses during the last 150 years. Because much of this historical alteration is reversible, the Snohomish estuary has unusually high potential for ecological restoration. To date, restoration projects cover nearly 10% of the historic estuarine wetland area, projects are planned at another 20%, and up to 45% is realistically restorable in the next decade. Coordination of monitoring efforts across projects and throughout the estuary allows for improved assessment of restoration effectiveness for individual projects but also presents a unique opportunity to evaluate cumulative effects of multiple projects. Fish use has been monitored across the Snohomish estuary for over a decade, and in 2009 we began comprehensive pre-project monitoring of elevation, hydrology, and biota (vegetation, invertebrates, birds, mammals, and fishes) at Qwuloolt, a 150 hectare site scheduled to have tidal influence returned in late 2014. Using data from these two sources, and in collaboration with federal, tribal, state, and local entities, we are developing and implementing both project level and estuary-wide monitoring programs. These will integrate efforts across restoration projects to rigorously evaluate restoration effectiveness, and also contribute to ongoing status and trends monitoring of ESA listed fish populations.

10:00 – 10:20 **Variation in early marine growth patterns of Chinook and chum salmon from estuarine/tidal delta habitats throughout Puget Sound.**

J. Chamberlin, B. Beckman (REUT, NWFSC), C. Greene, C. Rice, J. Hall

The early marine period has been identified as a critical stage for the overall survival of outmigrating juvenile salmonids. Mortality during this period is thought to be highly size-selective favoring faster growth and larger overall size. Insulin-like growth factor-I (IGF1) is highly correlated with growth rate in Pacific salmon (*Oncorhynchus* spp.) and has been used as a measure of instantaneous growth in several studies. We analyzed plasma IGF1 samples collected from Chinook and chum salmon from river delta habitats throughout Puget Sound to determine both spatial and temporal differences in growth among the separate species and evaluated the effect of both physical and biological predictors. Growth for both species varied significantly by basin and month of capture. Peak growth typically occurred in June or July and decreased relatively rapidly into September and October. However, the pattern was not consistent among geographic basins and was generally more pronounced for chum. Growth was less variable for wild Chinook when compared to hatchery fish, but overall, growth patterns between the groups were relatively similar. The observed spatial and temporal variation among growth patterns for Chinook and chum suggests that conditions that support growth during the early marine period vary throughout Puget Sound. Further investigations into the mechanisms that affect growth at the basin scale are warranted.

**10:20 – 10:40 Connectivity and estuary habitat use in juvenile fish: an analysis of tide gates in the Pacific Northwest.**

J. Hall, C. Greene, E. Beamer (Skagit River System Cooperative)

Estuaries in the Pacific Northwest are important rearing areas for a number of ecologically, commercially, and culturally important species, including Pacific salmon, forage fish, and flatfish. Most of the original estuary habitat within Puget Sound (80%) and Columbia River estuary (>65%) have been converted to agricultural, industrial, or residential land uses through diking and tide gates. Traditional tide gates passively limit hydraulic connectivity by opening during ebbing tides to allow freshwater runoff to drain and closing on the rising tide to prevent tidal flows back into the diked area. Consequently, traditional tide gates can restrict passage of fish, and change the ecological characteristics of the former estuarine wetlands into freshwater marshes and dry land. Replacing traditional tide gates with self-regulating “fish-friendly” tide gates (SRTs), which allow partial tidal inflow, has been proposed as a way to restore some of the original wetland structure and function required by salmon and other estuarine-rearing fish within diked areas while allowing some degree of fish passage. However, the design and operation of SRTs vary greatly and the physical and biological effects of these SRTs have not been rigorously examined. To address this knowledge gap, we examined the physical and ecological characteristics of ten existing SRTs in five different estuarine systems, as compared to traditional tide gates and natural channels. We also studied Chinook salmon densities at three SRTs over multiple years as compared to open channel reference sites. In both studies, we ask: how do SRTs influence local hydrologic processes and habitat use by aquatic organisms?

**BREAK 10:40 – 11:00**

**11:00 – 11:20 Oyster diets and ecosystem connectivity in Puget Sound.**

L. (Tish) Conway-Cranos (NOAA contractor - Frank Orth and Associates), P. Kiffney, N. Banas (UW), M. Plummer (CB, NWFSC), S. Naman (UBC), R. Paranjpye (REUT, NWFSC), M. Strom (SD, NWFSC), P. MacCready (UW), J. Bucci (UNH), M. Ruckelshaus (The Natural Capital Project)

Shellfish are a key component of nearshore temperate ecosystems and are affected by a suite of natural and anthropogenic processes that originate in both freshwater and marine habitats. Here we investigate the physical and biological extent of freshwater and marine influences to three shellfish growing areas in Puget Sound. Each of these locations supports large, commercially-harvested shellfish populations, but exhibits variation in land use (e.g., forested, agriculture), and near-shore hydrology. We use a fine-scale three dimensional oceanographic circulation model (MoSSea) to determine the extent of physical transport of freshwater to each shellfish growing area. We then examine the isotopic signature ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) of the Pacific oyster (*Crassostrea gigas*), collected from all three growing areas to understand the relative contribution of freshwater and marine trophic subsidies to shellfish diets. Potential diet items include phytoplankton, benthic diatoms, intertidal macrophytes (seaweeds and eelgrass), salt marsh plants and upland vegetation. Because shellfish populations depend upon the delivery of uncontaminated water originating from both land and sea, understanding the relative importance of freshwater and marine influences to shellfish beds is an important aspect of sustainable management of watersheds and nearshore ecosystems.

## Session 2 – Freshwater and Salmon Ecology

### 11:20 – 11:40 **Physical and biological responses to the use of beaver dams and beaver dam analogues to restore an incised, degraded stream in eastern Oregon.**

M. Pollock, C. Jordan (CB, NWFSC), N. Bouwes (Ecological Research Inc.), J. Wheaton (USU), C. Volk (South Fork Research, Inc.), N. Weber (Ecological Research Inc.)

We report results from a long-term restoration and monitoring program to help recover riparian and stream habitat in the John Day basin in eastern Oregon. We use a novel restoration technique, working with beaver (*Castor canadensis*), to restore an incised, degraded high desert stream that has a small native steelhead population. We hypothesize that beaver build dams that, if they remain intact, will substantially alter hydrology, geomorphology and sediment transport within the riparian corridor. Our restoration strategy is to provide beaver with low-cost instream structure so they can build stable dams, and also to create structures that mimic certain aspects of beaver dams in sites where vegetative or geomorphic conditions are not currently ideal for beaver colonization. The long term goal is to convert a linear, entrenched, simplified stream into a sinuous, structurally complex stream that is reconnected to its floodplain, resulting in a substantial expansion of riparian vegetation and improved instream habitat. We treated four reaches and compared them to four controls where no restoration occurred. Observations to date suggest that beaver dams in our treatment sites: 1) increase floodplain connectivity, by 2) raising water tables and increasing groundwater recharge, which 3) increases the extent of riparian vegetation. Additional ecosystem benefits include 4) increased pool frequency and depth, 5) increased stream sinuosity and sediment sorting and 6) lower stream temperatures. Finally, 7) a number of metrics suggest that juvenile steelhead populations have responded favorably to the treatment.

### 11:40 – 12:00 **Nomads no more - early coho migrants come home.**

T. Bennett, P. Roni, K. Denton, R. Moses (Lower Elwha Tribe), M. McHenry (Lower Elwha Tribe)

The downstream movement of coho salmon fry and parr to the marine environment has been well documented, but it has long been assumed that these “surplus fry” did not survive and return as adults. From 2004 – 2010 we PIT tagged more than 27,000 juvenile coho salmon in three streams in Washington State to determine their movement, survival, and the contribution of various juvenile life histories to the adult escapement. Detections of PIT-tagged adults revealed that fall/winter migrants contribute up to 37% of the return. Our results indicate that traditional methods of spring smolt enumeration may largely underestimate overwinter survival and total smolt production, and also overestimate spring smolt to adult return. These are important considerations for coho salmon life cycle models that assume juvenile coho salmon have a fixed life history or use traditional parr to smolt and smolt to adult return rates.

**12:00 – 12:20 Foodweb dynamics post dam removal: Year 1 results from the Elwha River.**

S. Morley, J. McMillan, H. Coe, O. Stefankiv, G. Pess, M. Elofson (Lower Elwha Tribe), M. McHenry (Lower Elwha Tribe), J. Duda (USGS)

Since the passage of the Elwha River Ecosystem and Fisheries Restoration Act in 1992, scientists have been gathering baseline data in anticipation of ecosystem responses to dam removal. Twenty years later, the Elwha Dam has finally been removed and Glines Canyon Dam deconstruction is nearing completion. Our monitoring work of the last decade has focused on aquatic foodwebs: nutrient availability, periphyton production, benthic invertebrate composition, and availability and selectivity of prey resources by juvenile salmonids. We hypothesized that in the short term (< 5 years post removal), benthic productivity would decrease due to the release of massive quantities of reservoir sediment. One year post dam removal, we found that benthic invertebrate density decreased dramatically below the Elwha Dam but that benthic algae did not. Densities of drift invertebrates were greatly reduced in the lower river post dam removal, and comprised of a higher proportion of terrestrial taxa. We are examining how these changes vary across different floodplain habitats, and how shifts in benthic production relate to changes in juvenile salmonid diet. Over the long term, we expect foodweb complexity to increase due to re-establishment of anadromous fish populations above both dams and increased floodplain heterogeneity below. Already, salmon have begun recolonizing the middle river and major geomorphic changes are underway. However, with only a fraction of sediment yet released from the Glines Canyon Dam, re-establishment of natural watershed processes continues evolving.

**12:20 – 12:40 The Elwha River - 1 1/2 years after the start of dam removal.**

G. Pess, J. McMillan, S. Morley, T. Beechie, K. Frick (FE, NWFSC), M. Liermann, K. Denton, O. Stefankiv, R. Moses (Lower Elwha Tribe), M. McHenry (Lower Elwha Tribe), L. Ward (Lower Elwha Tribe), R. Peters (USFWS), J. Duda (USGS), S. Brenkman (NPS), P. Crain (NPS)

In 2011 the multi-year decommissioning of two long-standing, high-head dams began on the Elwha River, Washington State. Over the past decade, we have been monitoring a variety of ecosystem attributes such as fish response, physical habitat conditions, and water quality parameters to establish baseline conditions prior to one of the largest watershed restoration projects in the US. The lower dam was removed during the spring of 2012 and steelhead (*Oncorhynchus mykiss*) naturally migrated upstream into the Middle Elwha within weeks. Natural recolonization by Chinook (*O. Tshawytscha*) and pink (*O. nerka*) salmon into the area between the two dams followed during the summer of 2012. Less than a year after the lower dam was removed, anadromous salmonids comprise up to 20% of summer juvenile salmon populations in the sampled river floodplain channels and tributaries. Adult spawner surveys and juvenile snorkel surveys suggest that juveniles are dispersing and colonizing additional habitats in the Middle Elwha. Elevated turbidity levels downstream of the dams have continued throughout decommissioning. Using several techniques including longitudinal profiles of floodplain channels, turbidity measures in differing habitat types, pebble counts, and fine sediment samples from riffle crests we have quantified the accumulation of clays, silts, sands, and gravels that has occurred in the main stem and floodplain areas of the Middle and Lower

Elwha. We will continue quantifying geomorphic and ecological changes to evaluate short and long-term ecosystem response in the Elwha River as well as to inform future dam removal projects.

#### LUNCH 12:40 – 2:00

#### 2:00 – 2:20     **The role of productivity for juvenile salmon populations in a changing climate.**

P. Kiffney, G. Pess, S. Naman (UBC)

Water temperature is a key variable determining individual performance (growth, body size, survival, movement) of fish, thereby affecting their population dynamics. On average, mean annual temperatures are predicted to rise from 2-4° C. Because fish metabolism increases exponentially with temperature, this increase will have important consequences for stream fish populations, as they must increase food intake to compensate for greater energy demands. Increased food intake may be challenging in rivers of the Pacific Northwest that support resident and anadromous salmonids, as these watersheds are naturally nutrient-poor and their productivity depends, in part, on marine nutrients and energy provided by spawning adult Pacific salmon. We present results from experiments and field studies that demonstrate the importance of prey availability to juvenile coho salmon, and how prey availability is directly linked to marine elements provided by dead salmon. We then present a case for how our results may be used in salmon recovery including recovery in a warming climate.

### **Session 3 – Science and Management Tools**

#### 2:20 – 2:40     **Incorporating climate change into river restoration designs.**

T. Beechie, M. Pollock, P. Roni, G. Pess, M. Collins (NOAA Restoration Center)

Future climate scenarios suggest that riverine habitats will be significantly altered in the next few decades, forcing managers to ask whether and how river restoration activities should be altered to accommodate climate change. Obvious questions include: Will climate change alter river flow and temperature enough to reduce action effectiveness? What types of restoration actions are more likely to remain effective in a climate-altered future? To help address these questions, we reviewed literature on habitat restoration actions and river processes to determine the degree to which different restoration actions are likely to either ameliorate a climate effect or increase habitat diversity and resilience. Key findings are that restoring floodplain connectivity and re-aggrading incised channels ameliorates both stream flow and temperature changes and increase lateral connectivity, whereas restoring in-stream flows can ameliorate decreases in low flows as well as stream temperature increases. Other restoration actions (e.g., reducing sediment supply, in-stream rehabilitation) are much less likely to ameliorate climate change effects. In general, actions that restore watershed and ecosystem processes are most likely to be robust to climate change effects because they allow river channels and riverine ecosystems to evolve in response to shifting stream flow and temperature regimes. We also illustrate how a modified restoration

design process can help determine whether a project design should be altered to accommodate climate change effects, and show examples of science information that can be used to alter restoration designs when necessary.

2:40 – 3:00     **The spatial distribution of salmon redds and optimal sampling design.**  
M. Liermann, D. Rawding (WDFW), G. Pess

Choosing locations to sample throughout a river network is a common challenge for scientists and managers. Many factors need to be considered in order to achieve the most precise estimate of the desired metrics given a fixed budget. These include a detailed description of the goals, the expected distribution of the metrics across sites (i.e. mean, variance, etc.), the degree that sites close together have similar values, the amount of prior information about the spatial distribution, and the cost of sampling different groups of sites. We use known redd locations for two Washington salmonid populations over several years to illustrate the effects of these different factors and how the available information can be used to improve the efficiency of the sampling design. Redd locations were clumped in space resulting in reach counts that were highly variable and skewed (i.e. many small values and a few very large counts). The clumping also resulted in spatial autocorrelation, where reaches closer together tended to have more similar counts. For simple random sampling this means that more reaches will need to be sampled to provide the same precision, and standard confidence intervals (CI) will tend to perform poorly (i.e. less than 95% coverage for a 95% CI). Stratified sampling, ratio estimators, and more spatially distributed designs such as generalized random tessellation sampling (GRTS) are all shown to improve precision without substantially increasing cost.

BREAK 3:00 – 3:20

3:20 – 3:40     **Monitoring adult salmon populations in the Elwha River with SONAR before and during dam removal.**  
K. Denton, M. Liermann, G. Pess, O. Stefankiv, A. Godersky (NOAA contractor - Frank Orth and Associates), J. McMillan, M. McHenry (Lower Elwha Tribe), R. Moses (Lower Elwha Tribe), J. Duda (USGS), R. Peters (USFWS), S. Brenkman (NPS)

Adult salmon enumeration on the Elwha River has traditionally been done through redd count surveys. However, the efficacy of these surveys has recently been greatly reduced due to the release of an unprecedented amount of trapped sediment from the removal of the Elwha River dams. In anticipation, we began monitoring adult salmon escapement with multi-beam SONAR technology in 2008. Our efforts have focused on ESA-listed Chinook salmon and steelhead. During this time period we have experimented with different SONAR types, deployment methods, and locations in the watershed. In addition, we have incorporated various statistical methods to produce run size estimates from our raw data and compare our escapement estimates to available redd count estimates. We have also attempted to characterize the species composition of our SONAR targets. Our SONAR-based Chinook salmon estimates were approximately 50% higher than redd based estimates the first two years of operation, but have come closer to agreement in the last two years. In addition, we have been able to operate as turbidity levels have increased in the last 1 ½ years without compromising our ability to

enumerate. Steelhead have proven more difficult to accurately record due to the challenging hydrological conditions during their spring run timing. Nevertheless, we have been able to produce estimates of escapement where minimal data previously existed. Reliable estimates of adult salmon populations are of extreme importance in the Elwha, as the response of adult populations will likely be the key metric in measuring the success of dam removal.

3:40 – 4:00     **Using a stream network census of fish and habitat to assess models of juvenile salmonid distribution.**

J. McMillan, G. Pess, M. Liermann, J. Starr, X. Augerot (Marys River Watershed Council)

During two consecutive summers we censused juvenile salmonids and stream habitat across a stream network. We used the data to test the ability of habitat models to explain the distribution of juvenile coho salmon *Oncorhynchus kisutch*, young-of-the-year (age 0) steelhead *Oncorhynchus mykiss*, and steelhead parr ( $\geq$  age 1) for a network consisting of several different sized streams. Our network-scale models, which included five stream habitat variables, explained 27%, 11%, and 19% of the variation in the density of juvenile coho salmon, age 0 steelhead, and steelhead parr, respectively. We found weak to strong levels of spatial autocorrelation in the model residuals (Moran's *I* values ranging from 0.25 - 0.71). Explanatory power of base habitat models increased substantially and the level of spatial autocorrelation decreased with sequential inclusion of variables accounting for stream size, year, stream, and reach location. The models for specific streams underscored the variability that was implied in the network-scale models. Associations between juvenile salmonids and individual habitat variables were rarely linear and ranged from negative to positive, and the variable accounting for location of the habitat within a stream was often more important than any individual habitat variable. The limited success in predicting the summer distribution and density of juvenile coho salmon and steelhead with our network-scale models was apparently related to variation in the strength and shape of fish-habitat associations across and within streams and years.

4:00 – 4:20     **Designing effective stream and watershed restoration: guidance based on three decades of restoration science.**

P. Roni, T. Beechie, G. Pess

Hundreds of millions of dollars are spent annually to restore salmon habitat. Unfortunately, many of these well-intentioned efforts fail to meet their objectives because they ignore watershed processes or do not follow key steps needed to adequately plan, implement and evaluate restoration. Here we provide an overview of the key factors needed to plan restoration, assess watershed conditions, identify restoration actions, select and prioritize restoration techniques and evaluate restoration projects. We provide examples of successful methods used to address each of these key steps. Before assessing conditions or identifying restoration opportunities, it is important to have a clearly defined restoration or recovery goal. Assessment of watershed processes and habitat conditions should include assessment of potential and current rates or conditions, and identify the causes of habitat degradation and loss. In selecting appropriate

restoration actions, it is important to be aware of whether the actions restore underlying processes or simply improve habitat as well as the longevity and likelihood of success. Several approaches exist for prioritizing restoration actions and these largely depend on goals of restoration. Monitoring of restoration projects needs to be designed well before the projects are implemented and have clear testable hypotheses and rigorous study design. Unfortunately, many monitoring programs fail not because of inadequate design, but because of poor implementation, quality control and management – all factors that can usually be overcome by diligent project management. The steps and considerations outlined above, if followed, will help assure that restoration actions are effective at restoring watershed processes and habitat.

4:20 – 4:30    Closing Comments – Phil Roni, Watershed Program Manager